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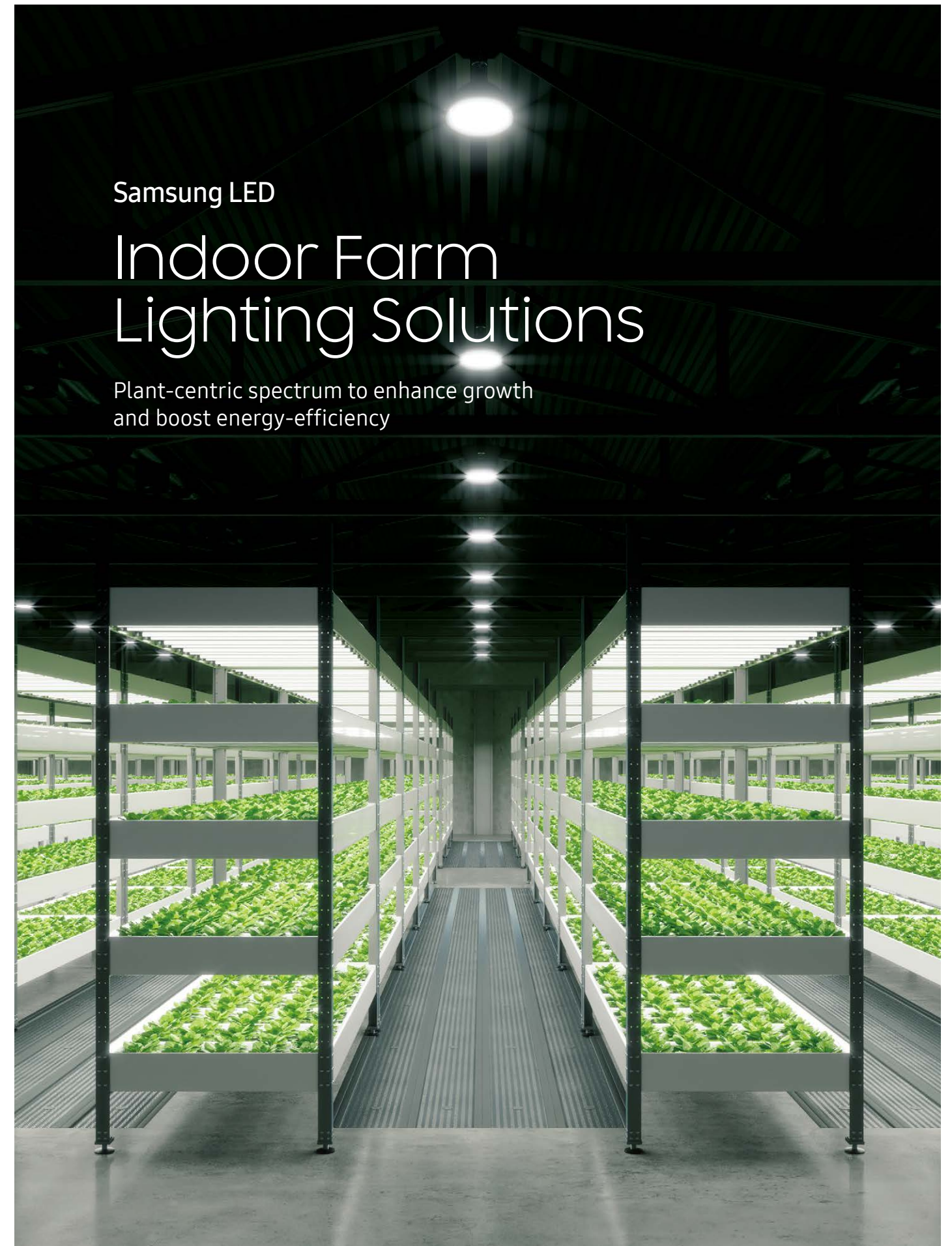
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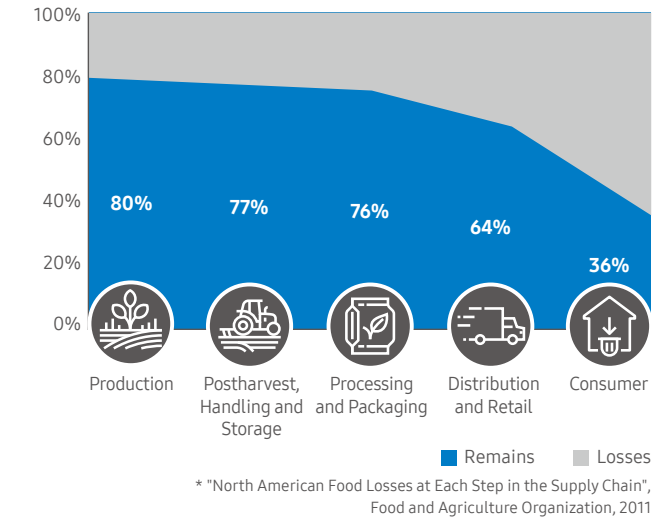
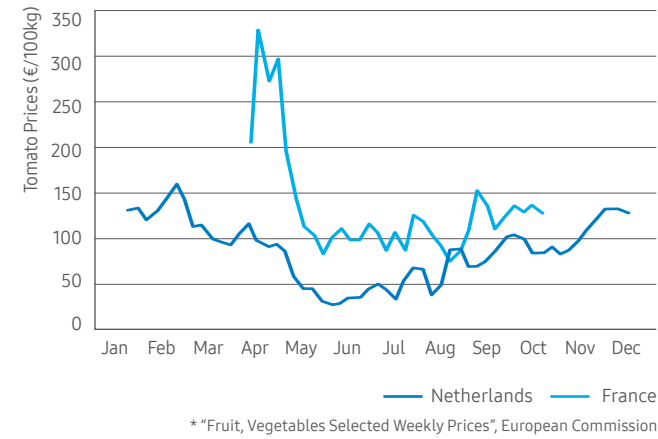




# Indoor Farm Lighting Trends

## Needs for Indoor Farm Lighting to Obtain Stable Crop Production

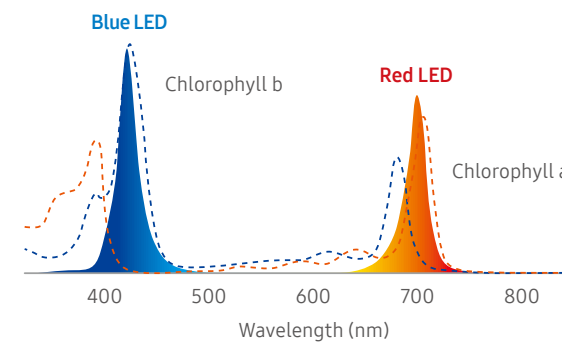
Due to unstable crop supplying and food losses, indoor controlled environment agriculture is becoming a new trend worldwide. It requires to provide stable lights under elaborate control for better plant growth.



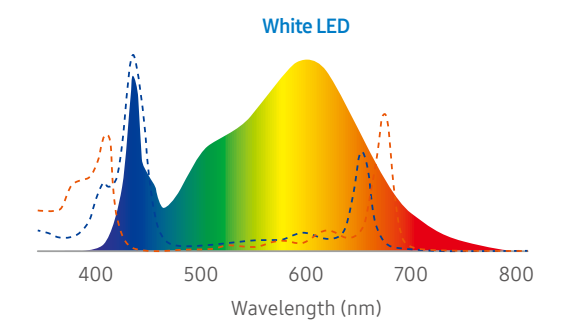
## White-based Full Spectrum LED for Indoor Farm Lighting

Full spectrum is recent trend with more cost-effective, productive, and favorable solution

### Narrow Spectrum



### Full Spectrum





# Samsung Plant-centric Spectrum LEDs for Indoor Farm Lighting



**Lower Operation Cost**  
 Industry-leading PPE for energy saving

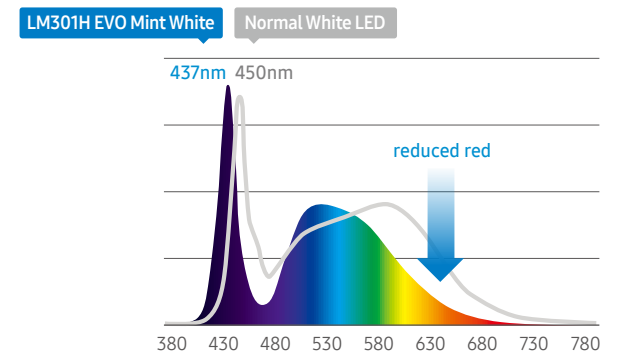
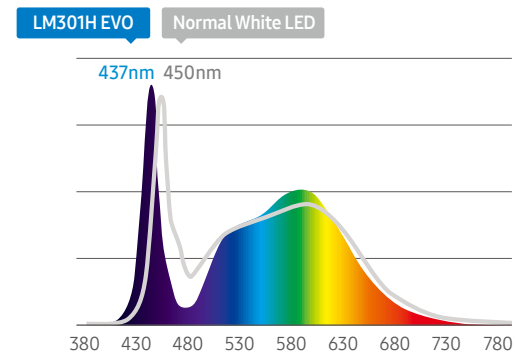
**Boosting Growth**  
 Differentiated spectrum for better plant growth

**Keeping Crops Fresh**  
 Suppressing microbial growth for longer shelf life

**Robustness**  
 Device architecture for durability

## Industry-leading Efficacy

### Samsung's Novel Plant-centric Spectrum



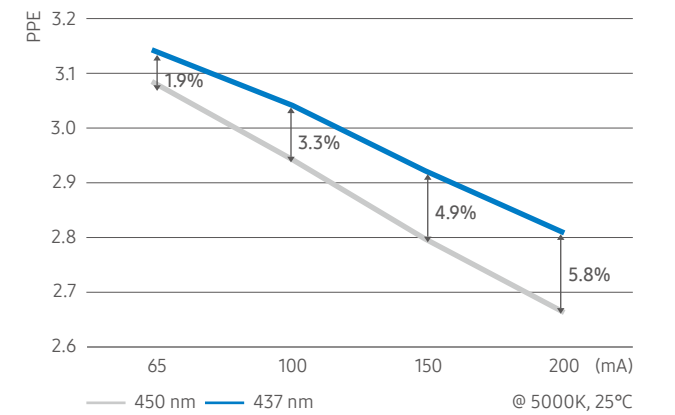
### Industry-leading PPE under High Current Conditions

Ultimate Solution for Highest PPE

	Plant-centric Spectrum LED	Normal Full Spectrum LED	Remark
Form Factor (mm <sup>2</sup> )	3.0 * 3.0	3.0 x 3.0	-
Spectrum Peak (nm)	437	450	-
PPF/W (μmol/J)	3.14	3.08	+2%

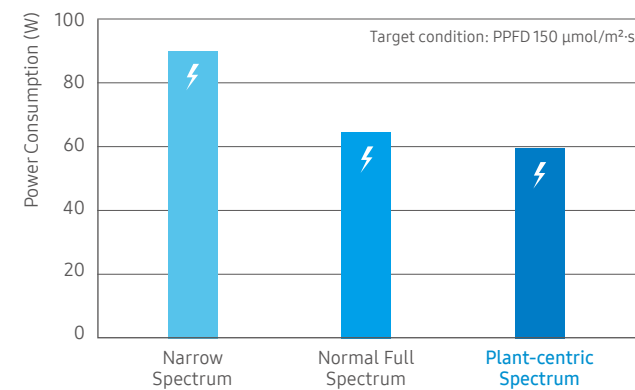
@ 65 mA, 25 °C, 5000K,

High PPE Maintenance by Current

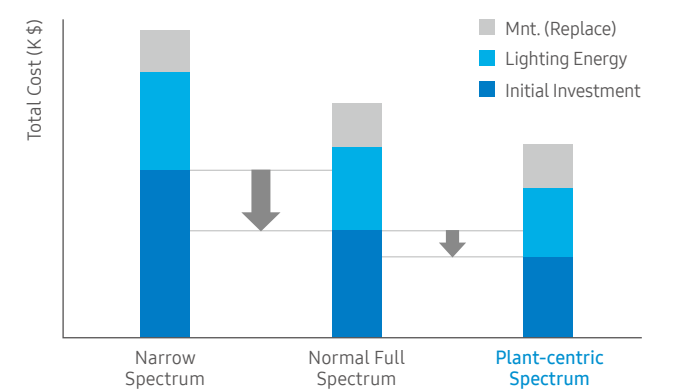


### Saving Energy Consumption for Lower Operation Cost

Thanks to the industry-leading PPE, Samsung's Plant-centric Spectrum LEDs bring the total cost down with the lowest initial investment and lower energy consumption.



\* Acknowledgement: Prof. Son at Gyeongsang National Univ.

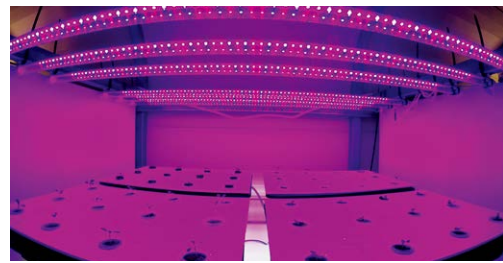




# Better Plant Growth

## I Spectrum Comparison Experiment

- Test Period: April 26th to June 4th, 2021
- Plants: Butterhead lettuce, Romaine lettuce
- Growth Condition
  - Temperature: ave. 20±3°C
  - Relative humidity: ave. 80
- Light Variables
  - Light spectrum under same power consumption (80W)
  - Light spectrum under same PPFD (150 μmol/m<sup>2</sup>·s)
- Measurements
  - Plant growth
  - Antioxidants concentration
  - Microbial growth



**Narrow Spectrum LED**  
Blue (450nm) + Red (660nm)



**Normal Full Spectrum LED**  
Full White (450nm) + Red (660nm)



**Plant-centric Spectrum LED (LM301H EVO Mint White)**  
Mint White (437nm) + Red (660nm)



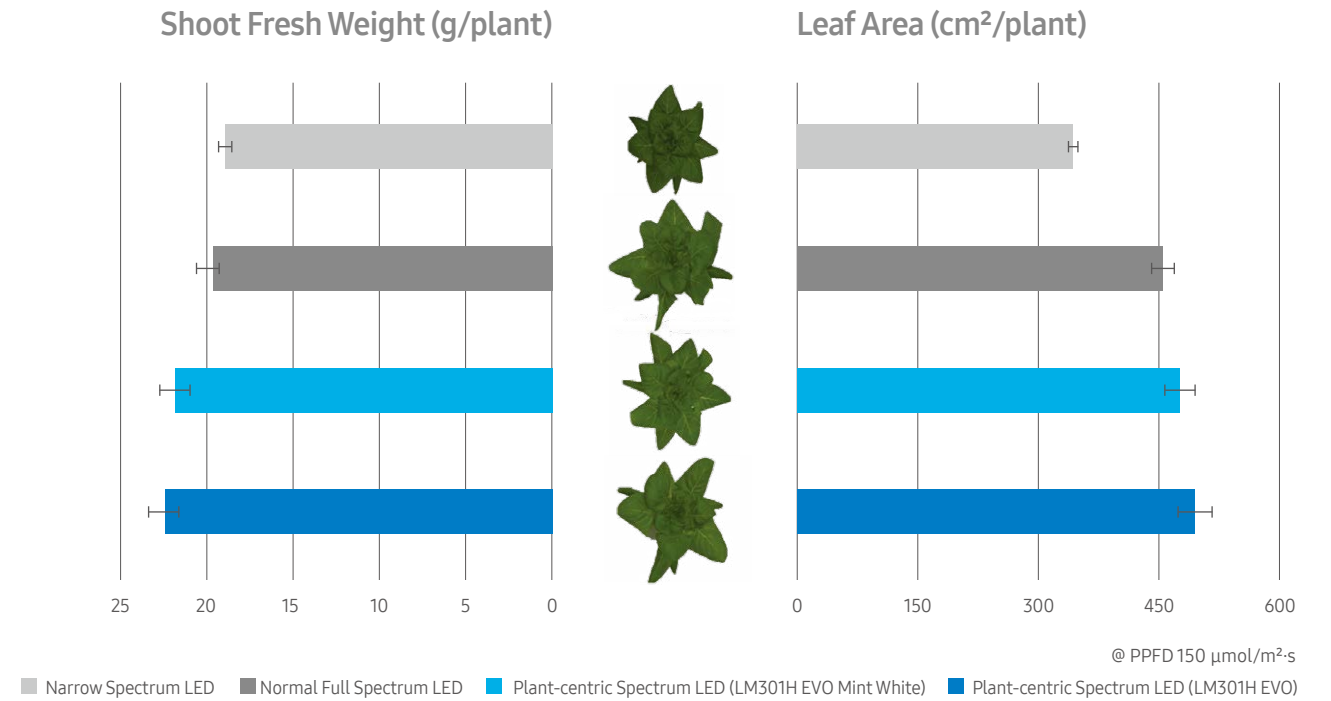
**Plant-centric Spectrum LED (LM301H EVO)**  
Full White (437nm) + Red (660nm)



\* Acknowledgement: Prof. Son at Gyeongsang National Univ.

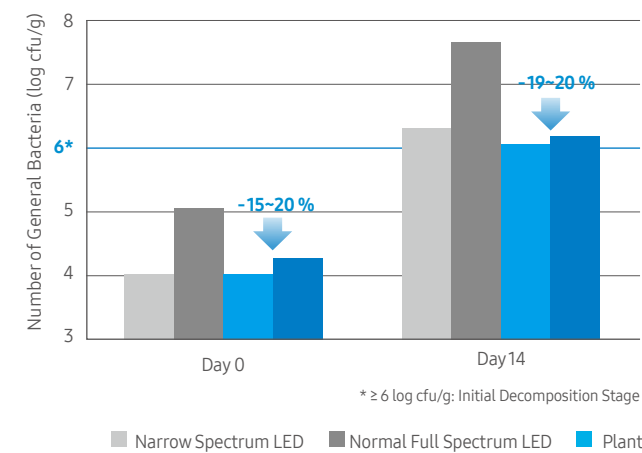
## I Better Plant Growth with Differentiated Spectrum

Even under the same PPFD conditions, Samsung's unique spectrum leads to larger and heavier growth.



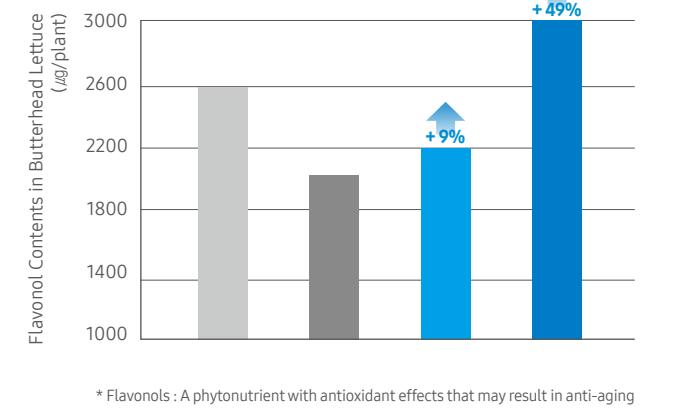
## I Longer Shelf Life

Shorter wavelength suppresses microbial growth leading to longer shelf life.



## I Enhanced Bioactive Compounds of Crops

437nm spectrum produced the highest quantity of flavonols\* in butterhead lettuce.

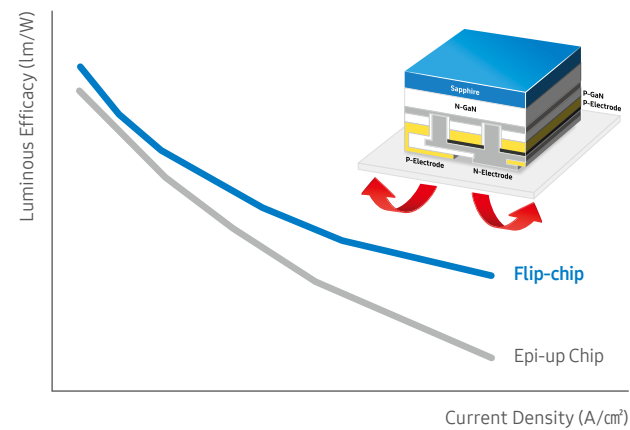


# Robust Performance

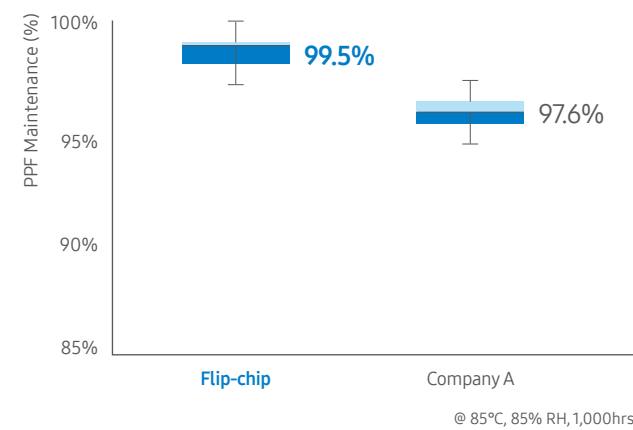
## Excellent Heat Management

Samsung's flip-chip technology exhibits better thermal dissipation, resulting in preventing potential wire-open and blackout failure and maintaining superior efficacy in higher current density conditions

### High Performance Maintenance by Current



### High Temp/Humidity Operation Test

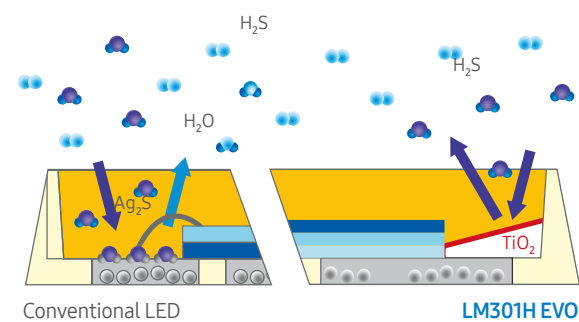


## Superior Sulfur Resistance

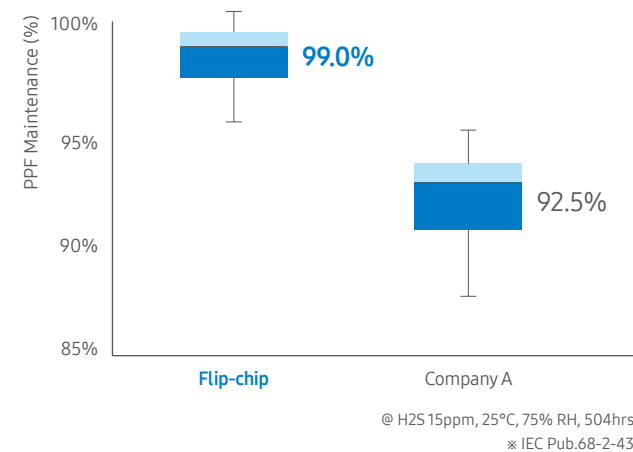
With a reflector structure and coating, Samsung's horticulture LEDs can present superior sulfur resistance in indoor farm conditions.

### Samsung Horticulture Package

- Ag in wire or electrodes can be tarnished when exposed to H<sub>2</sub>S
- $2Ag + H_2S + 1/2O_2 \rightarrow Ag_2S + H_2O$  (Ag<sub>2</sub>S causes PPF degradation)
- LM301H EVO: Flip-chip with no wire



### Sulfur Resistance Test



# Product Line-up

## White Mid Power LEDs

Samsung's mid-power white LEDs deliver the highest efficacy and excellent reliability

### LM301H EVO



- Plant-centric light spectrum for better growth
- World's best efficacy
- Anti-sulfurization (with flip-chip technology)

@65mA, 25°C, 5000K, CRI80+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm²)
PR	White	0.56	3.14	3.0 × 3.0

### LM301H EVO Mint White



- Plant-centric light spectrum for better growth
- World's best efficacy
- Anti-sulfurization (with flip-chip technology)

@65mA, 25°C, 5000K, CRI70+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm²)
PM	White	0.57	3.17	3.0 × 3.0

### LM301H



- Optimized light spectrum for leafy greens
- Anti-sulfurization (with flip-chip technology)

@65mA, 25°C, 5000K, CRI80+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm²)
SL	White	0.54	3.08	3.0 × 3.0

### LM301H ONE



- Optimized light spectrum for leafy greens
- Anti-sulfurization (with flip-chip technology)

@65mA, 25°C, 3500K, CRI70+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm²)
S0	White	0.49	2.75	3.0 × 3.0

## White High Power LEDs

Full line-up of high power white LEDs with industry-proven performance for various horticulture applications

### LH241H



- Compact design for small LES module
- Viewing angle: 120°
- Thermal resistance: 2.0K/W

@350mA, 25°C, 5000K, CRI70+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm²)
R1	White	2.51	2.52	2.4 × 2.4

### LH281H



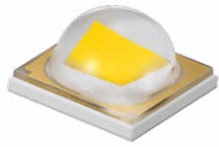
- Compact design for small LES module
- Viewing angle: 120°
- Thermal resistance: 2.0K/W

@350mA, 25°C, 5000K, CRI70+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm²)
SB	White	2.59	2.65	2.8 × 2.8

# Product Line-up

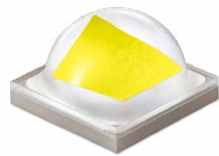
## LH351H-B



- Viewing angle: 120°
  - Thermal resistance: 4.2K/W
- @350mA, 25°C, 5000K, CRI70+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Q1	White	2.48	2.51	3.5 × 3.5

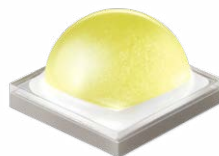
## LH351H-C



- Viewing angle: 130°
  - Thermal resistance: 3.0K/W
- @350mA, 25°C, 5000K, CRI70+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
RB	White	2.56	2.60	3.5 × 3.5

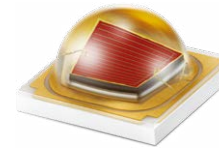
## LH351H-D



- Viewing angle: 130°
  - Thermal resistance: 2.2K/W
- @350mA, 25°C, 5000K, CRI70+

Rank	Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Y2	White	2.58	2.69	3.5 × 3.5

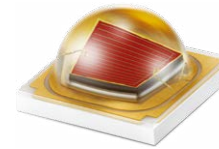
## LH351H Deep Red (660nm) V2



- Viewing angle: 130°
  - Thermal resistance: 3.0K/W
- @700mA, 25°C

Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Deep Red	5.54	3.75	3.5 × 3.5

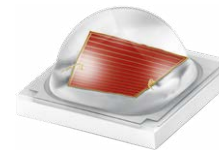
## LH351H Deep Red (660nm) V2+



- Viewing angle: 130°
  - Thermal resistance: 3.0K/W
- @700mA, 25°C

Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Deep Red	5.6	3.8	3.5 × 3.5

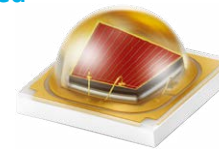
## LH351H Deep Red (660nm) V3



- Viewing angle: 130°
  - Thermal resistance: 3.0K/W
- @700mA, 25°C

Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Deep Red	5.65	3.9	3.5 × 3.5

## LH351H Far Red (730nm)



- Viewing angle: 120°
  - Thermal resistance: 3.9K/W
- @350mA, 25°C

Color	* BPF (μmol/s)	* BPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Far Red	2.07	3.1	3.5 × 3.5

\* Biologically-active Photon Flux

## Color High Power LEDs

Full line-up of high power color LEDs with industry-proven performance for various horticulture applications

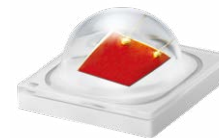
## LH351H Blue (450nm)



- Viewing angle: 130°
  - Thermal resistance: 4.0K/W
- @350mA, 25°C

Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Blue	2.80	2.80	3.5 × 3.5

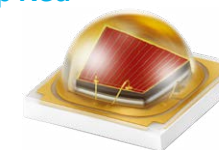
## LH351H Red (630nm)



- Viewing angle: 120°
  - Thermal resistance: 4.0K/W
- @350mA, 25°C

Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Red	1.82	2.41	3.5 × 3.5

## LH351H Deep Red (660nm)



- Viewing angle: 120°
  - Thermal resistance: 2.5K/W
- @350mA, 25°C

Color	PPF (μmol/s)	PPF/W (μmol/J)	Footprint (mm <sup>2</sup> )
Deep Red	2.4	3.22	3.5 × 3.5

## Module

Customized designs are also available per customer request

## Horticulture LED Module Gen2



Color	PPF (μmol/s)	PPF/W (μmol/J)	Luminous Flux (lm)	Watt (W)	Vf (V)	IF (mA)	Efficacy (lm/W)	Tp (°C)
White + Red	154.2	3.06	8,960	50.4	42	1,200	178	25

\* Subject to change without notice